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Original communication

Pesticide poisoning trend analysis of 13 years: A retrospective study based on telephone calls at the National Poisons Information Centre, All India Institute of Medical Sciences, New Delhi

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ABSTRACT

The study was designed to analyze the incidence and pattern of pesticide poisoning calls reported to the National Poisons Information Centre (NPIC), AIIMS, New Delhi and highlight the common classes of pesticides involved in poisoning. The telephone calls received by the Centre during the thirteen year period (1999–2012) were entered into a preset proforma and then into a retrievable database. A total of 4929 calls of pesticide poisoning were recorded. The data was analyzed with respect to age, gender, mode and type of poisoning. The age ranged from 1 to 65 years with the preponderance of males (M = 62.19%, F = 37.80%). The age group mainly involved in poisoning was 18–35 years. While 59.38% calls pertained to household pesticides, 40.61% calls related to agricultural pesticides. The common mode of poisoning was intentional (64.60%) followed by accidental (34.40%) and unknown (1%). Amongst the household pesticides, the highest number of calls were due to pyrethroids (26.23%) followed by rodenticides (17.06%), organophosphates (6.26%), carbamates (4.95%) and others (4.86%). In agricultural pesticides group, the organophosphates (9.79%) ranked the first followed by, aluminium phosphide (9.65%), organochlorines (9.31%), pyrethroids (3.87%), herbicides, weedicides and fungicides (3.20%), ethylene dibromide (2.82%), and others (1.70%). The data analysis shows a high incidence of poisoning due to household pesticides as compared to agricultural pesticides, clearly emphasizing the need for creating awareness and education about proper use and implementation of prevention programmes.

1. Introduction

There is an extensive worldwide production and use of pesticides, aimed at increasing agricultural yields, crop variety and preservation. Pesticides have also been used in domestic and public health domains. Their benefits are numerous but the damages are appalling, especially when misused. Acute poisoning with pesticides due to accidental and intentional exposure is an important cause of morbidity and mortality. The actual incidence of poisoning due to pesticides is not known, because all patients do not report to hospitals. Further, all poisoning calls are also not reported to the Poison Centres.

Poisoning due to pesticides and the associated mortality is a worldwide problem.[1] In developing countries, where large quantities of pesticides are used, there is an increased incidence of accidental and intentional poisoning, resulting in a large number of deaths.[2–4] The risk of poisoning is further increased, especially in rural setting, where the agriculture dependent populations often store them in and around their homes. The WHO reports a high mortality due to pesticides from developing countries.[5] On the contrary, the US Poisons Control Centres report a decline in both incidence and mortality rate due to pesticides.[6]

India is one of the largest producers of pesticides in Asia, but the consumption is low.[7] The indiscriminate and non-judicious use of pesticides poses a serious challenge to human health and consequently to environment. Extrapolation of data based on a study from India, estimates an annual mortality of more than 5000 people due to pesticide poisoning in the State of Andhra Pradesh alone.[8]

There are a number of hospital based studies in India, highlighting poisoning due to pesticides.[9–12] But reports based on telephone calls made to Poison Centres in our country are scarce.[13–15]

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In India, the National Poisons Information Centre (NPIC) in the Department of Pharmacology at the All India Institute of Medical Sciences (AIIMS), New Delhi, provides round-the-clock telephone service on management of various poisonings, all over the country.[16] The data analysis of the telephone based poisoning calls received by NPIC indicates that both household and agricultural pesticides were commonly consumed.

Therefore, the present retrospective study, based on the telephone calls made to the Centre, is aimed to determine the incidence of intentional and accidental poisoning due to pesticides. The study also highlights the common classes of products involved in poisoning. However, the actual incidence of poisoning due to pesticides in India may differ from the present results due to under reporting of poisoning cases in India.

2. Methods

The telephone calls received by the Centre were entered into a preset proforma and then into a retrievable database. The call details sought from the caller included the enquirer's name, address, patient's age, sex, route of exposure, mode and symptoms of poisoning, treatment already provided and necessary queries about the patient. The information desired by the caller was conveyed after consulting the database and literature. All the information about the calls was documented.

Pesticides were divided into two groups, viz household pesticides (Gr.I) and agricultural pesticides (Gr.II). The household pesticides (Gr.I) comprised products which are primarily used in households mainly as mosquito and cockroach repellants, insecticides and rodenticides. The agricultural pesticides (Gr.II) comprised various formulations of insecticides, herbicides, weedicides, fungicides etc used in agricultural fields.

3. Results

During the study period (1999–2012), a total of 14,867 poisoning calls were received by the NPIC. Poisoning calls due to pesticides (n = 4929) were reviewed retrospectively (Fig. 1). The queries mainly included information on first-aid measures, nature of product consumed, likely signs and symptoms, treatment, specific antidotes, their dosage and availability. The age ranged from less than 1 to 65 years. The age group mainly involved in poisoning was 18–35 years. The number of males were found to be more than females (M = 62.19%, F = 37.80%). The common mode of poisoning was intentional (64.60%) mainly in the age group of 18–35 years, followed by unintentional (34.40%). There were 1270 (36.59%) calls involving children below 16 years of age. Children below the age of 6 years were mainly involved in accidental poisoning (62.31%). The mode of poisoning was unknown in a few cases (1%). The commonest route of exposure was oral (99.93%) followed by dermal (0.05%) and inhalation (0.02%) routes.

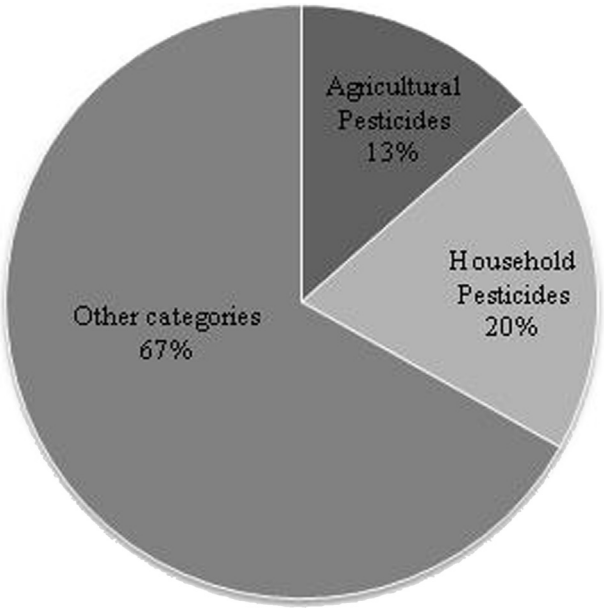

Fig. 1. Incidence of pesticide poisoning.

The household pesticides consisted of 59.38% (n = 2927) and agricultural pesticides comprised 40.61% (n = 2002) calls (Table 1). The number of cases due to household pesticides has shown an increased trend as compared to agricultural pesticides (Fig. 2). Amongst the household pesticides (Gr.I), the highest incidence was due to pyrethroids (26.23%) followed by rodenticides (17.06%), organophosphates (6.26%), carbamates (4.95%)and an insecticide containing elemental mercury, used for grain preservation in households (4.86%) (Table 1). An increased incidence in poisoning was noted due to pyrethroids and rodenticides over thirteen years, as compared to organophosphates and carbamates which have shown a decline in use (Fig. 3).

In the agricultural pesticides group (Gr.II), organophosphates (9.79%) were most commonly used followed by aluminium phosphide (9.65%), organochlorines (9.31%), pyrethroids (3.87%), herbicides and weedicides (3.20%), ethylene dibromide (2.82%). Carbamate insecticides used in agriculture were involved in very few cases (0.24%) (Table 1). Aluminium phosphide, organochlorines and organophosphates have shown a rise in incidence over the past few years (Fig. 4).

4. Discussion

In India, there are a number of hospital based studies on acute poisoning due to pesticides, but reports on poisoning calls based on telephone queries in general and pesticides in particular are scarce.

A retrospective analysis of the telephone calls on pesticide poisoning received by NPIC was carried out. The number of calls received by the Centre was much less as compared to other Poison Centres in the world. On the contrary, a higher number of calls have been reported in lesser period by Milan Poisons Control Centre.[17]

The likely reason for less number of calls made to NPIC could be the hesitation to call the Centre, because of medico legal hassles and the social stigma associated with intentional poisoning in India. The underutilization of the services of the Centre and less

Table 1
Types of pesticides consumed.

	No. of cases, n = 4929	%	Total %
Household pesticides			
Rodenticides	841	17.06	59.38
Pyrethroids	1293	26.23	
Organophosphates	309	6.26	
Carbamates	244	4.95	
Others	240	4.86	
Agricultural pesticides			
Organophosphates	483	9.79	40.61
Aluminium phosphide	476	9.65	
Organochlorines	459	9.31	
Carbamates	12	0.24	
Pyrethroids	191	3.87	
Ethylene dibromide	139	2.82	
Herbicides/weedicides	158	3.20	
Others	84	1.70	

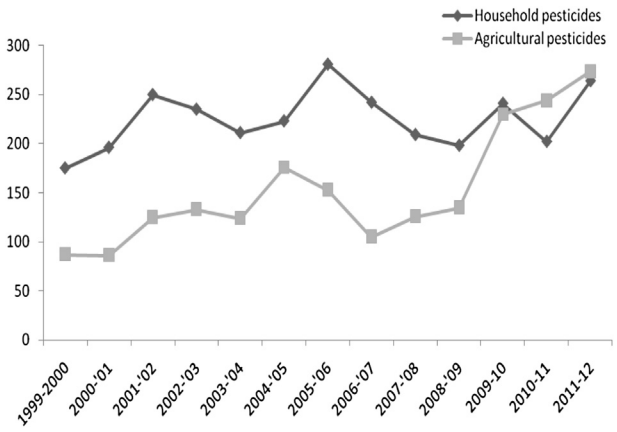

Fig. 2. Year wise trend of calls due to household and agricultural pesticides.

telephonic penetration in the population could also be the plausible reasons.

In both the groups of pesticides analyzed, males outnumbered females corroborating other studies.[8,17–20] In contrast, preponderance of females has also been reported.[21,22]

The common mode of poisoning was intentional followed by accidental in consonance with other literature reports.[8,23,24] Intentional poisoning is a major problem worldwide and suicidal attempts with pesticides have been widely reported from Asia.[5,20,25] According to a representative mortality survey in India, nearly half of the deaths due to suicides in adults were mainly due to intentional ingestion of pesticides.[26] Reports from South India indicate suicide as a common mode of poisoning with pesticides. In fact, majority of deaths have been reported in young women after self poisoning with pesticides.[27,28]

The likely contributory factors for intentional attempts especially among males could be easy access, careless storage, emotional conflicts, professional stress, frustration due to family feuds and low socioeconomic status. A national plan for prevention of suicide with pesticides has been implemented by some countries including Sri Lanka. The regulatory control involving the use and availability of highly toxic pesticides, has led to a decrease in mortality.[29]

Children were mainly involved in accidental poisoning due to household pesticides. A number of studies in children report poisoning due to pesticides.[30,31] Children especially toddlers tend to lick everything due to curiosity and exploratory nature. Besides, casual handling of various household products by parents and care takers also leads to an increase in the number of cases.

The pattern of poisoning due to pesticides shows a different trend when compared to other hospital based reports from India, where pesticides involved in poisoning are well reported, but have not been distinctly categorized into household and agricultural groups. Due to variable socioeconomic and geographical conditions, a variation in products misused and frequency is observed.

In the present study the products in Gr.I comprised pesticides which are used in households mainly as insecticides and rodenticides. The highest incidence was due to pyrethroids, found in insect repellant mats and aerosols.

Pyrethroids are a group of synthetic analogues, used as insect knock downs. They are generally available as repellant chalks and

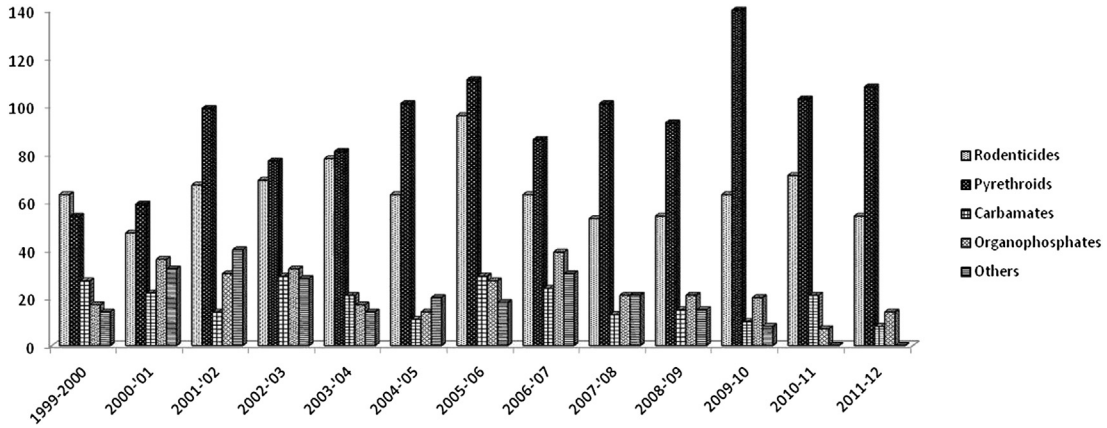

Fig. 3. Trend in incidence due to household pesticides.

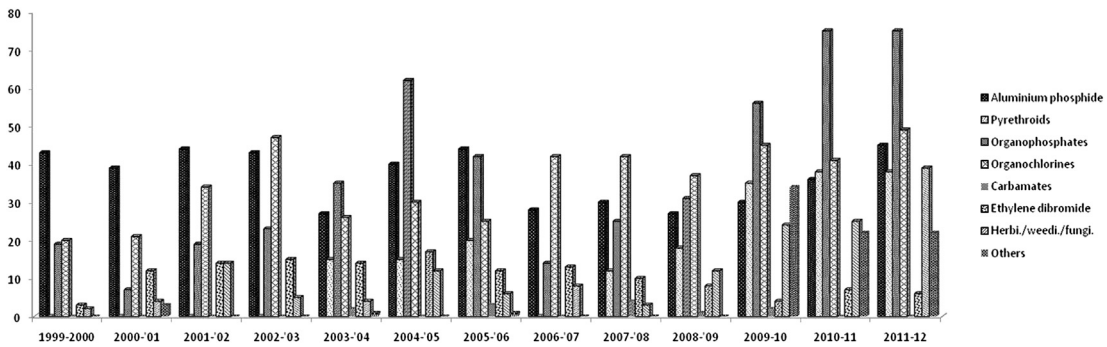

Fig. 4. Trend in incidence due to agricultural pesticides.

mats. Many formulations in petroleum distillates are also marketed in cans for spray applications. Modifications in preparations help to improve stability in the natural environment and resist photolysis. Piperonyl butoxide is added as a synergist that inhibits pyrethroid metabolism. Pyrethroids disrupt the functioning of the nervous system of insects by altering the membrane ion transport system in nerve axons.[32]

Widespread use of pyrethroids has been noted over the last few years, probably due to low risk of adverse effects on mammals, and hence the flooding of the market with new substitutes. Very low mortality has been reported with their use.[32] In fact various formulations used in households generally have low concentration of the active compound, which results in increased risk due to formulation rather than active compound. Fatality due to the hydrocarbons in which they are formulated has been reported.[33]

Poisoning due to pyrethroids has been reported by the Poisons Centres abroad as well.[17,18] The US Poisons Control Centres document an increased use of pyrethrins and pyrethroids following phase out and elimination of organophosphates in residential areas.[34]

The next ranking group among the household pesticides was rodenticides comprising zinc phosphide, barium carbonate and superwarfarins. Poisoning due to these agents is well reported in literature.[12,18,19,35,36] Zinc phosphide, releases phosphine gas upon exposure to moisture causing cellular hypoxia. Barium carbonate is a neuromuscular blocker. Superwarfarins inhibit the synthesis of factors II, VII, IX, X in liver producing significant anticoagulation.

Organophosphates and carbamates cause the inhibition of enzyme acetyl cholinesterase, increasing the concentration of acetylcholine at the nerve endings. The use of household organophosphates (fenitrothion, diazinon, malathion) and carbamates (propoxur) which were previously common has declined. Availability of less toxic alternatives like pyrethroids in the market has led to their phase out.

Poisoning due to agricultural pesticides is very well reported in literature.[8,18,37] A study from India carried out at primary, secondary and tertiary healthcare levels, documents highest incidence due to agrochemicals, with maximum number of cases reported from primary health centres.[12]

In India an increasing trend in incidence of poisoning due to AlP has been observed during the past three decades.[35,38] The present study also reports a high incidence due to AlP amongst the agricultural pesticides in conformity with other reports.[23,35,39,40]

AlP is a very effective grain fumigant, used predominantly in the northern States of India. It has been associated with high mortality.[10,35,41] AlP releases phosphine gas upon contact with moisture. The mechanism of action is not clear. It is suggested, that it causes the inhibition of electron transport chain in mitochondria resulting in hypoxia and shock. Lipid peroxidation has also been reported.[42] The target organs of toxicity are heart and lungs. There are changes in cardiac transmembrane action potentials culminating in necrosis and heart failure.[43] A significant correlation between ECG abnormalities and mortality has also been observed.[44]

A persistent increase in incidence of exposure to AlP with declining mortality has been reported from India. Restricted sale of the pesticide could be an important responsible factor.[10] Use of AlP and the associated poisoning mainly restricted to India in the past, has also been reported from Iran, where self poisoning with AlP is common.[45,46]

Organophosphate (OP) formulations containing malathion, monocrotophos, chlorpyrifos, dichlorvos, fenitrothion, phorate were commonly ingested. Poisoning due to agricultural pesticides containing OPs is widely reported from India and abroad.[10,17,19,20,47] Most self poisoning deaths in Central and South India are reported due to OPs and organochlorines (OCs).[8] In fact India reports a high incidence and fatality rate with OPs.[48] On the contrary, evaluation of the data from US Poisons Centres shows a markedly decreasing trend in poisoning due to OPs and carbamates.[6]

Organochlorines consisted mainly of Gamma benzene hexachloride (γ-BHC) and endosulfan. These axon poisons interfere with the normal flux of sodium and potassium ions across the axon membrane, leading to CNS toxicity. Poisoning due to organochlorines is well reported from India.[8,12] Episodes of endosulfan poisoning and morbidity associated with its use are well documented.[49,50] Recent studies have reported increased fatalities with endosulfan from Sri Lanka.[51]

Ethylene dibromide (EDB), a grain fumigant, and a preservative has been implicated in a number of cases. It is an enzyme inhibitor that mainly targets the liver. High incidence of poisoning and mortality has been reported with EDB in India.[52,53] Poisoning due to herbicides, fungicides, pyrethroids though reported in literature was recorded in the present study, but to a lesser extent.[54,55]

The trend in pattern of poisoning due to two groups of household and agricultural pesticides as discussed could be variable when compared with hospital based studies. Since all patients especially from rural areas do not report to healthcare facilities, even, the hospital based studies cannot truly represent the country at large. The exact incidence can only be represented by a central registry. However, the present study highlights the increasing accidental and intentional use of household pesticides which warrants necessary attention.

5. Conclusion

The results of the study show an overall increase in the number of poisoning calls reported to the NPIC. A higher number of calls due to household pesticides have been reported. Easy availability and largely careless storage of pesticides could be responsible for poisoning in households as well as in the fields. This calls for emphasis on proper and safe storage of various products, especially at home and strict adherence to instructions for use.

Further, it is mandatory to restrict the use of highly toxic pesticides and conduct special farmer's education programmes, to highlight adverse health risks, proper use, storage and disposal of agricultural pesticides. Since India is an agrarian country, reliance on pesticides is tremendous. Hence safe storage and judicious use in a prescribed way can help, achieve a degree of safety to a large extent. Emphasis should be laid on WHO recommendations of safe storage, education strategies and psychosocial interventions to reduce pesticide related deaths.

Ethical approval
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Conflict of interest
None declared.

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